DEFENSE INNOVATION UNIT EXPERIMENTAL

ARL S&T Campaign

The U.S. Army Research Laboratory (ARL) – the Army's corporate research laboratory – The overarching goal of the ARL Technical Strategy is to provide the vision, key technical focus areas, and principal transition pathways which are essential in assuring the continued strategic land power dominance of the United States Army.

ARL's Technical Strategy highlights a coordinated and synchronized S&T campaign framework guiding the essential S&T efforts that will provide the future Army with the capabilities to conduct prompt, sustained, and synchronized operations with a force customized to the mission and poised to prosecute both combat and noncombat missions in all functional domains – air, ground, maritime, space, and cyberspace. Central to this construct are eight S&T campaigns focused on:

ARL's Extramural Basic Research Campaign is focused on the Physical Sciences, Information Sciences, Life Sciences, and Engineering Sciences. External research efforts in these areas are strongly linked to ARL's in-house research portfolio through the myriad of transition vehicles, including collaborative research in many cases. Discoveries and innovations made in extramural basic research will exert a significant impact on the Army of the future.

Computational Sciences Campaign The areas of emphasis include Predictive Simulation Sciences; Data Intensive Sciences; Computing Architectures; and Computing Sciences.
Predictive Simulation Sciences concentrates on understanding and exploiting the fundamental aspects of verified and validated computational simulations that predict the response of complex Army systems and guide Army materiel design, particularly in cases where routine experimental tests are extremely difficult to conduct or not feasible.
Data Intensive Sciences focuses on understanding and exploiting the fundamental aspects of large-scale, multi-dimensional data analytics. Experiments, observations, and numerical simulations are on the verge of generating petabyte-quantities of data. These massive amounts of data are distributed across disparate locations and pose a challenge in providing real-time analytics that support U. S. military operations.
Computing Architectures concentrates on understanding and exploiting the fundamental aspects of hardware and associated system software for emergent and future computing architectures for mobile, scientific, and data intensive applications. Computing systems include both mobile and fixed/virtual architectures optimized for fast communications, low power consumption, large hierarchical memory, novel and robust algorithms, high resiliency, and HPC networking.
Computing Sciences concentrates on understanding and exploiting the fundamental aspects of computer science research related to ease of programming, computing environments, languages, and reusable programming models for Army specific applications.

Materials Research Campaign Plan The areas of emphasis include Structural Materials; Electronics; Photonics; Energy and Power; Biotechnology and Bio-Inspired; Lethality and Protection; and Manufacturing Science, Processing, and Sustainment.
Structural Materials is focused on novel and specialized materials to enhance the structural efficiency and systems performance of advanced platform structures while maintaining the same or greater levels of protection compared to today's platforms.
Electronics is focused on specialized electronic materials and devices to achieve Army dominance over the entire electromagnetic spectrum, particularly in contested environments. The two primary thrusts of this area are Energy Efficient Electronics and Hybrid Electronics. Energy Efficient Electronics is focused on low-power-demand electronic components having increased performance capabilities; and Hybrid Electronics focuses on high performance, conformable, and flexible electronics for advanced sensors and processors.
Photonics is focused on materials and devices for photonic sensors and sources; scalable high energy lasers; secure communications via quantum networking; and protection of sensors and human eyes against high power and short pulse laser threats.

Energy and Power is focused on materials and devices for more efficient power generation; energy storage; energy harvesting; fuel processing; micropower; and novel alternative energy solutions at lower cost.
Biotechnology and Bio-Inspired is focused on new biological materials derived through synthetic biology as well as classical approaches. Novel biological materials are combined with inorganic devices to sense chemical and biological agents; generate power from organic sources; and produce materials to create new protection designs inspired by nature.
High Strain Rate and Ballistic Materials is focused on novel and specialized materials to enhance the performance and efficiency of Army weapons and protection systems including lightweight, extreme performance materials; novel energetic materials; and energy absorbing materials.
Manufacturing Science, Processing, and Sustainment is focused on discovery, innovation, and maturation of manufacturing innovations to facilitate agile, adaptive, mobile processing and manufacturing capabilities to enable superior performance and implementation of cost reduction methodologies. Sustainability is focused on understanding material properties and degradation mechanisms to improve durability of Army systems in extreme environments.

Sciences-for-Maneuver The emphasis areas include Energy and Propulsion; Platform Mechanics; Platform Intelligence; and Logistics and Sustainability.
Energy and Propulsion concentrates on understanding and exploiting the applications of energy generation, storage, conversion, and management. The goal of this research is to provide energy and power applications to enhance Army operational effectiveness, improve efficiency, and accelerate development of critical military platform systems ensuring Army Power Projection superiority.
Platform Mechanics focuses on fundamental research that enables the development of the highly maneuverable platforms for the Army of the future.
Vehicle Intelligence focuses upon fundamental research that enables effective teaming of Soldiers and robots to conduct maneuver and military missions. ARL's activities are centered upon enhancing the autonomous capabilities of unmanned systems.
Logistics and Sustainability focuses on fundamental research to enable the rapid and reliable assessment of future Army platform reliability, health, and usage.

Information Sciences The emphasis areas include Sensing and Effecting; System Intelligence and Intelligent Systems; Human and Information Interaction; Networks and Communications; and Cyber Security.
Sensing and Effecting research concentrates on understanding and exploiting information gained through sensing and exploiting data to drive effectors. Both sensing and effecting necessitate detailed understanding of corresponding physical behaviors that generate and utilize data, as well as effective means for storage, retrieval, and manipulation of data.
System Intelligence and Intelligent Systems research concentrates on understanding and exploiting interactions between information and intelligent systems, such as robots and software agents, wherein information is transformed between different levels of abstraction and roles within the intelligent system's cognitive processes – recognition, reasoning, predictions, and decision-making.
Human and Information Interaction research concentrates on understanding and exploiting interactions between information and humans, which involves complex mixed-initiative processes of information acquisition, transformation between levels of abstraction and relevance, comprehension, negotiation, and interactive tasking – mutually between humans and Army information systems.
Networks and Communications research concentrates on understanding and exploiting information's interactions with socio-technical networks, particularly communications, and command and control networks, both formal and social. Such interactions are heavily influenced by complex channels and protocols requiring complex analyses to understand and predict emergent behaviors of networks.
Cyber Security research concentrates on understanding and exploiting interactions of information with cyber attackers – human and/or intelligent agents. These interactions involve friendly operations against adversary information systems and networks, defense of friendly information systems and networks, and assurance of persistent information support to Soldiers even when parts of the friendly systems and networks are compromised.

Sciences-for-Lethality and Protection
The Sciences-for-Lethality and Protection technical emphasis areas include Lethality Research for Soldiers and Army Platforms; Protection Research for Soldiers and Army Platforms; and Battlefield Injury Mechanics.
Lethality Research for Soldiers and Army Platforms concentrates on understanding and exploiting the fundamental aspects of launch and control; electronic attack; directed energy mechanisms; and target effects.
Protection Research for Soldiers and Army Platforms concentrates on understanding and exploiting the fundamental aspects of protection against ballistic threats; directed energy threats; and CBRNE threats.
Battlefield Injury Mechanisms concentrates on understanding and exploiting the fundamental aspects of human combat injury mechanisms.

Human Sciences The areas of emphasis include Human-Physical Interface; Human-Human Interface; and Human-Technology Interface.
Human-Physical Interface fundamental research focuses on better understanding the relationship between the brain and the body, and interactions with the physical environment. Fundamental understanding gained in genetics and genomics; molecular biology; and human biochemistry and their impacts on brain structure-function coupling are expected to be essential in augmenting warfighter performance. Physical-cognitive interactions – especially in the operational environment – are expected to influence warfighter behavior; learning and decision making; and multisensory perception.
Human-Human Interface fundamental research is focused on better understanding one-to-one, one-to-many, and many-to-many interactions. The focus of this area is on providing and evaluating effective personnel training, leader development, and team building through fundamental understanding and enhancement of motivation, physical resilience, cognitive resilience, and trust. Understanding and exploitation of the fundamental aspects of social networks dynamics; organizational structure optimization; and ethics, values, trust, social-cultural, economic, and geopolitical effects are expected to be critical in influencing group dynamics and performance.
Human-Technology Interface fundamental research is focused on understanding how humans interact with materiel and information. Fundamental research areas of interest include ergonomics and biomechanics to increase Soldier performance while simultaneously minimizing injury probability; physical augmentation to improve physical load management; wearable and implantable systems and devices for protection and for medical applications; and brain-computer interactions dedicated to understanding and enhancing cognitive performance and protection against cognitive harm.

Assessment and Analysis
The Assessment and Analysis Campaign is highly rigorous with a focus on addressing vulnerability and susceptibility challenges to development of Army-critical materiel systems. The areas of emphasis include Assessment of Science and Technology; Science and Technology of Assessment; Assessing Mission Capability of Materiel; and Material Capable of Assessing Mission Capability.
Assessment of Science and Technology concentrates on understanding the costs and benefits of R&D efforts, their readiness levels, risks, potential payoffs, and integration challenges.
Science and Technology of Assessment concentrates on understanding the key types of analytical problems likely to confront the Army of 2030, exploiting the latest developments by our academic and industrial partners, and performing basic and applied research to develop the powerful new tools required.
Assessing Mission Capability of Materiel concentrates on understanding and exploiting systems' technologies, design, and employment together with current – and likely future – state of the art developments to optimize future designs and to inform evaluation and acquisition decisions with analyses that are both technically sound and practically efficient. Key to this effort, are methodologies to integrate technical assessments into the science and engineering domain with considerations of mission effectiveness for the materiel's operational user.
Materiel Capable of Assessing Mission Capability concentrates on understanding and exploiting developments in the other S&T campaigns to evolve assessment and analysis itself from a laboratory service to a technology that we transition to the warfighter.